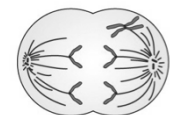## Topics

- Meiosis
  - Genetic variation
- Errors in cell division
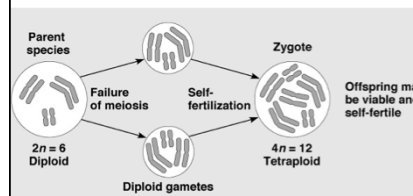 - Cancer
- Review

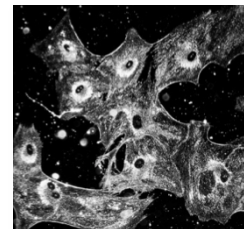## Meiotic errors

Anaphase

1) Nondisjunction

Incorrect binding of spindle to the kinetochore

2) Aneuploidy

Eg. polyploidy
Extra set of chromososomes, due to additional replication or lack of spindle

Meiotic and mitotic errors

Cancer

Cancer is a large class of diseases characterized by **uncontrolled cell growth** and **tissue invasion**

Cancerous human brain cells

A **tumor** is a localized growth of **transformed** cells

Transformed cells are not recognized as problematic by the immune system and grow unchecked (they are **immortal**)

What causes

Certain gene **mutations** can eventually lead to uncontrolled growth.

- Enzyme mistakes in replicating DNA

- External DNA insults such as ionizing radiation and chemicals

    See **mutagens** previously discussed

- Sexual reproduction (meiosis crossing over)

** Not all mutations are "**bad**"*

Hallmarks of Cancer

- Dedifferentiation
- Loss of cell cycle, or contact inhibition, control

Differentiation:

Contact Inhibition

Mammalian cells in a dish "anchor" to the bottom of the plate (anchorage dependence)
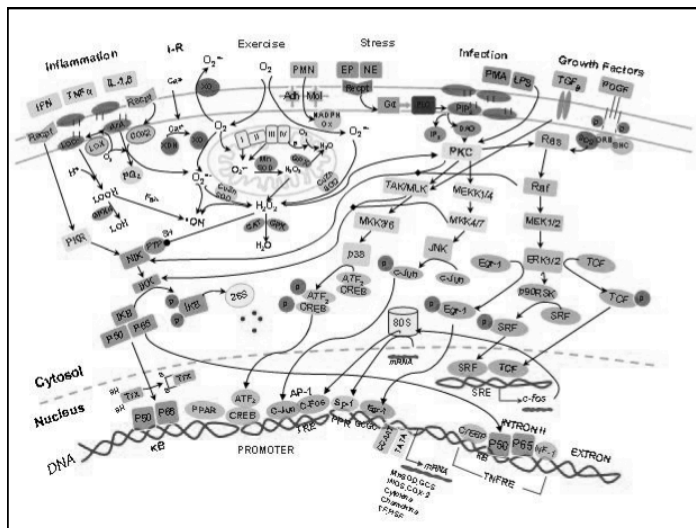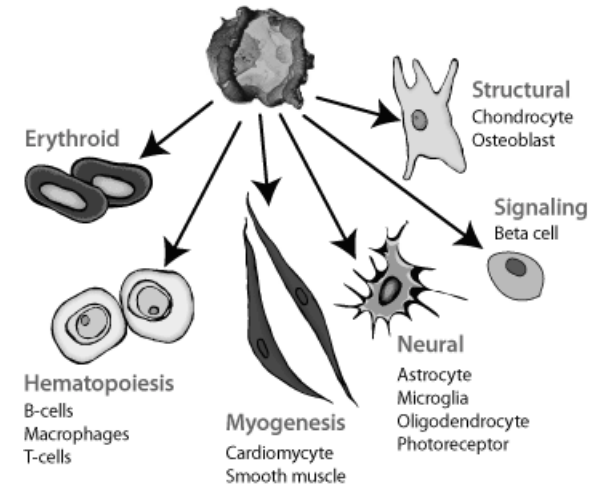
Cells will grow until confluent and are inhibited by contact with other cells - **Contact inhibition**

Contact inhibition in normal epidermal cells.

Contact Inhibition
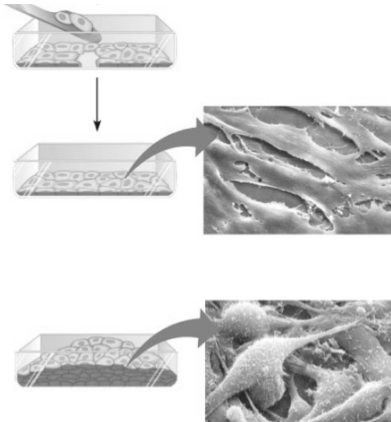
Cancer cells lose both **anchorage dependence** and **contact inhibition**

HeLa Cells
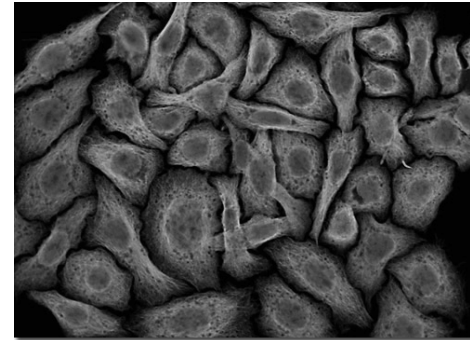
The cell line was derived from cervical cancer cells taken from Henrietta Lacks, who died from her cancer in 1951.
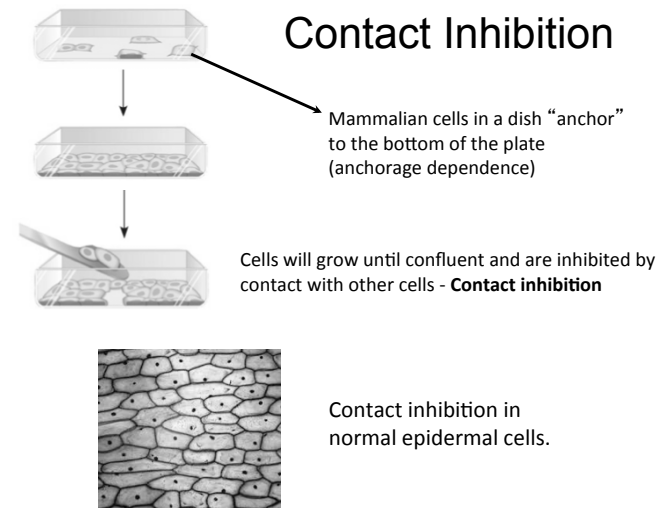
Hallmarks of Cancer

- Dedifferentiation
- Loss of cell cycle, or contact inhibition, control
- Unrecognized by the immune system
- Metastatic

Metastasis

cells grow as a benign tumor in epithelium   break through basal lamina   invade capillary

connective tissue   basal lamina

capillary   travel through bloodstream (less than 1 in 1000 cells will survive to form metastases)

Tumor cells may enter the bloodstream directly by crossing the wall of a blood vessel.

This is an extremely rare event.
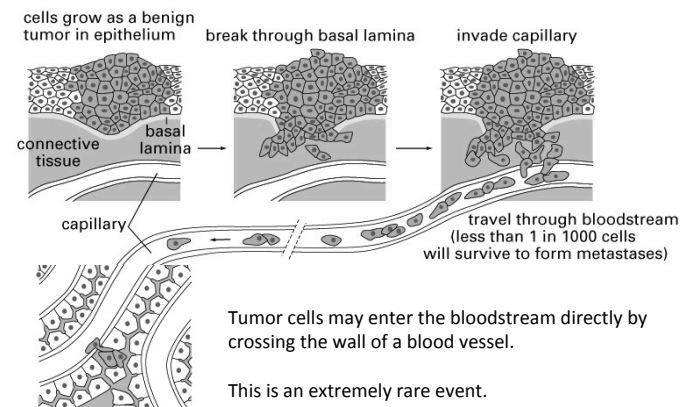
Cancer

A term that encompasses 100s of different diseases

Stages of Tumor Development

A tumor develops from multiple genetic **mutations**

invasive cancer

in situ cancer

cell with genetic mutation

hyperplasia

dysplasia

blood vessel

Inhibition of blood vessel growth

mutations

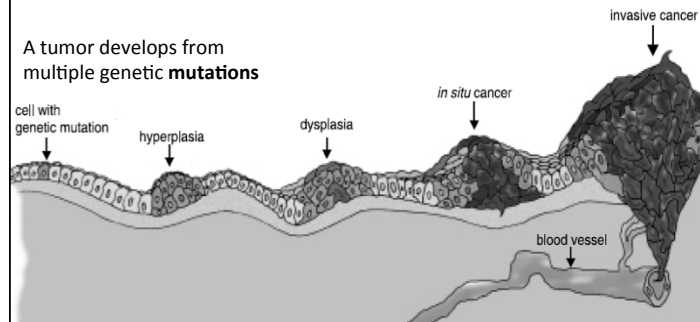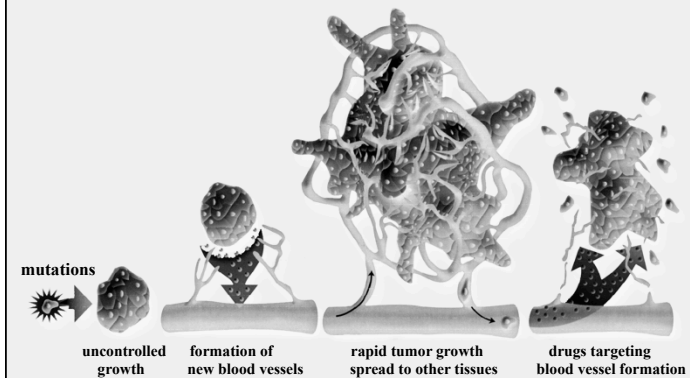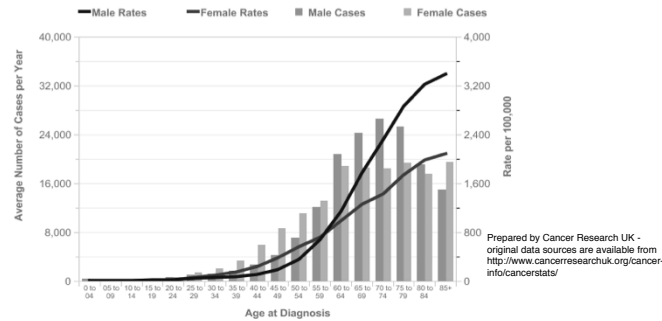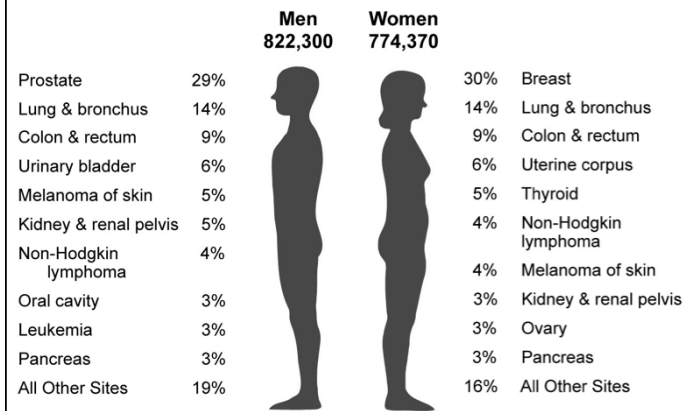| uncontrolled growth | formation of new blood vessels | rapid tumor growth spread to other tissues | drugs targeting blood vessel formation |

Cancer and Age

All Cancers Excluding Non-Melanoma Skin Cancer (C00-97 Excl. C44): 2008-2010
Average Number of New Cases Per Year per 100,000 Population, UK

Prepared by Cancer Research UK - original data sources are available from http://www.cancerresearchuk.org/cancer-info/cancerstats/

Cancer incidence rises steeply with age.

This is a good indication of how cancer requires **multiple genetic mutations**. If it only required one mutation it would be far less dependent on age.

2011 Estimated US Cancer Cases*

Men 822,300

Prostate	29%
Lung & bronchus	14%
Colon & rectum	9%
Urinary bladder	6%
Melanoma of skin	5%
Kidney & renal pelvis	5%
Non-Hodgkin lymphoma	4%
Oral cavity	3%
Leukemia	3%
Pancreas	3%
All Other Sites	19%

Women 774,370

30%	Breast
14%	Lung & bronchus
9%	Colon & rectum
6%	Uterine corpus
5%	Thyroid
4%	Non-Hodgkin lymphoma
4%	Melanoma of skin
3%	Kidney & renal pelvis
3%	Ovary
3%	Pancreas
16%	All Other Sites

Source: American Cancer Society, 2011   Source: American Cancer Society, 2011.

*Excludes basal and squamous cell skin cancers and in situ carcinomas except urinary bladder.

2011 Estimated US Cancer Deaths

		Men 300,430	**Women** 271,520		
Lung & bronchus	28%			26%	Lung & bronchus
Prostate	11%			15%	Breast
Colon & rectum	8%			9%	Colon & rectum
Pancreas	6%			7%	Pancreas
Liver & intrahepatic bile duct	4%			6%	Ovary
Leukemia	4%			4%	Non-Hodgkin lymphoma
Esophagus	4%			3%	Leukemia
Urinary bladder	4%			3%	Uterine corpus
Non-Hodgkin lymphoma	3%			2%	Liver & intrahepatic bile duct
Kidney & renal pelvis	3%			2%	Brain/Other nervous system
All other sites	22%			23%	All other sites

Concluding the Cell Cycle